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In a region of concentrated rainfall and long drouths the river mouths become temporarily closed, and the abundant aquatic and other life in the lagoons thus formed contributes to the organic acid of the waters which, upon penetrating the wall or dam of beach sand, first dissolves the lime, and then redeposits it when it comes in contact with the dense sea-water on the ocean side. In this manner some portions of the beaches have been hardened, while others have remained incoherent.

The density of the ocean water is in all probability considerably greater during the dry than during the rainy season, and this would still further hasten the consolidation of the beaches during dry seasons.

The process of beach-hardening is not a continuous one, but varies with geographic and climatic conditions. New reefs may be formed behind the older ones on the shores of the estuaries and embayments.

The monograph is closed by a chapter on the associated coral reefs.

T. C. C.

The Copper Deposits of the Encampment District of Wyoming. By ARTHUR C. SPENCER. (Professional Paper No. 25, 1904.) Pp. 107; 2 plates and 49 figures.

THE district of which Mr. Spencer treats in this report comprises some 450 square miles in southern Wyoming, so situated that the southern boundary of the area lies close to the Colorado line, while the one hundred and seventh meridian bisects it. The encampment district is crossed diagonally from southeast to northwest by the irregular line of the Continental divide, which is the crest of the Sierra Madre Mountains. The maximum elevation is 11,007 feet (Bridger Peak), and the minimum 6,650 feet.

The structure is essentially a low arch or anticline whose axis is parallel with the mountain crest, that is, east-west. The core of this arch is made up of a mass of hornblende schists and sedimentary rocks, closely folded and overturned to the north, the whole forming a complex east-west synclinorium. These rocks are said to be pre-Cambrian, though the reasons for this conclusion are not given. They were invaded at a later period by basic igneous rocks related to gabbros. The hornblende schists appear everywhere to be the basement upon which the sediments were laid down.

Flanking these pre-Cambrian rocks is a series of Mesozoic and Cenozoic sediments which are now confined to the southwestern part of the area, as a remnant of a great mantle of sediments that formerly covered the whole arch. These formations dip away to the south beneath the surrounding prairie. The oldest of these formations is the "Red Beds" series of the

Trias. Above these lie Jurassic, Cretaceous, some small patches of Tertiary strata, and, on the higher elevations, glacial deposits.

The pre-Cambrian rocks and the intruded gabbro are the most important from the standpoint of the economic geologist, for it is with these that the ore deposits are connected.

As indicated by the title of the paper, copper ores are the chief ores of this district, though some lead and silver, and a trifling amount of gold, in quartz veins, have been found. The copper minerals comprise chalcopyrite, bornite, chalcocite, and covellite, with their usual alteration products. The principal gangue minerals are quartz, calcite, siderite, feldspar, hornblende, epidote, and garnet.

Some of the metallic sulphides crystallized contemporaneously with the silicate minerals of the rocks; others are supposed to be of later origin, and to have been formed by impregnation of the schists by the intrusive norite. A common origin by aqueous deposition is assigned to the remaining ores, and they are found in all channels of easy circulation. Their ultimate source is attributed to the basic igneous rocks of the region, which contain appreciable amounts of copper, and in many cases cobalt and nickel as well.

The most important ores commercially are those (chalcocite) found along the bedding planes and brecciated zones in the pre-Cambrian quartzite. Here secondary enrichment has taken place.

W. D. S.

Recent Seismological Investigations in Japan. By BARON DAIROKU KIKUCHI. Private Publication.

THIS important paper was prepared as an address to be delivered at the Congress of Arts and Science at St. Louis, but, as the author was unexpectedly prevented from attending the Congress, it was printed privately and distributed by him. It is, however, a much more elaborate paper, and much more amply illustrated, than would be inferred from the statement that it is an address. It covers 145 pages, and is accompanied by 54 illustrations relating to earthquake effects, earthquake-proof structures, instruments of observation and their records, geographic distribution, and related subjects. The paper sets forth with much fulness the work of the Earthquake Investigation Committee of Japan in connection with the Seismological Institute of the Tokyo University—work which must be regarded as among the most important now in progress. A chapter is given to the geographical and chronological distribution of earthquakes—